Securing the future of space:
Space Software and Data/AI

CPD Course Handbook

Cohort 1- 2024

Securing the future of space: Space Software and Data/AI CPD Course

Contents:

Welcome to the "Securing the future of space: Space Software and Data/AI" CPD Course

We are delighted to welcome you, our first cohort, to the **Securing the future of space: Space Software and Data/AI** CPD Course. We recognise the importance of working closely with the sector to design bespoke, broad, and strategic concepts to include in the course, ensuring that participants not only acquire technical proficiency, but also develop an understanding of the strategic implications of these technologies for their organisations.

Becky Canning, Associate Professor and Deputy Director (Space) at the University of Portsmouth's Institute of Cosmology and Gravitation, explains: *"Software, data, and AI development proceeds at such a rate that remaining at the forefront of the sector is challenging, yet these digital skills are critical to drive innovation and meet the objectives of the National Space Strategy.*

There are critical recruitment and retention bottlenecks at mid-career level, which need to be addressed. It is a delight to be working with my colleagues in the Space South Central region to address these key skills gaps and help remove barriers to the sector's growth"

Louise Butt, Director of the Space South Central Enterprise Network, adds: *"Hampshire, Surrey and the Isle of Wight have a stellar 50-year heritage of space innovation and expertise, and the range of specialisms here is unrivalled anywhere in the UK. Yet, skills gaps, shortages and recruitment challenges are the biggest threats to South Central England's £3 billion space sector.*
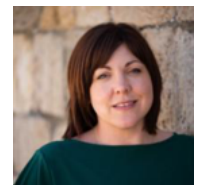
Our mission is to ensure that our region stays at the forefront of the UK space industry, and a significant part of that is supporting the development of training opportunities and helping employers of all sizes attract and retain the staff they need."

Hugh Lewis, Professor of Astronautics at the University of Southampton, says: *"It's a real privilege to be able to work with our colleagues in the Space South Central region to support the career development of professionals in the space sector and to guide them through a complex and ever-evolving landscape of data from space and about space.*

These data are vital for understanding our planet and the health of the satellites that deliver essential functions for our communities. We're able to build on more than 60 years of education and training offered by the University of Southampton to ensure this new training programme delivers the skills needed in an effective and enjoyable way."

Keith Ryden, Professor of Space Engineering at the University of Surrey, says: *"The Surrey Space Centre is delighted to be joining this new UKSA-funded initiative to address the growing industry requirement for more skilled people to work on data and software for space applications. We look forward to contributing through our strengths in remote sensing data analysis, on-board data processing and space data security and working closely with colleagues at the universities of Portsmouth and Southampton in this exciting initiative."*

Why is this course needed?
This CPD programme is funded through UK Space Agency's Training Programmes Fund and has been specifically designed to enable companies to overcome the skills deficits in 'Software and Data/AI' at the mid-career level.

The Space Sector Skills Survey 2023 notes the number one skills gap (>20% higher than other skills) in the sector is in 'Software and Data' (72% gap) with employers' expectations that the future will bring even greater challenges (81% gap predicted). Furthermore, 'Artificial intelligence and machine learning' and 'data analysis & modelling' are the only technical skills of the top 15 skills gaps in the current workforce which have worsened, alongside 'strategy and leadership'.

The space sector experiences critical recruitment and retention bottlenecks at mid-career. Respondents to the Skills Survey note that recruitment of people with 3+ years' experience is a challenge and often expensive to acquire the correct skill sets. Mid-level software and data/AI skills are in high demand.

Software and algorithmic development, especially in the AI/ML and IOT fields, proceeds at such a rate that remaining at the forefront of the sector is challenging. This course has been co-created with our customer base to align with the specific needs of space sector companies to enable them to strategically navigate the rapidly changing fields of AI and data-science.

Who is this course for?
This course specifically aims to upskill individuals to fill a 'mid-career' skills gap at companies in the space sector (mid-career as defined by Skills Survey is 3+ years). The course is aimed at employees already in the space sector who are looking for promotion and to fulfil critical employer gaps, as well as professionals outside the sector who want to direct their talent towards the fast growing space industry.

The various sessions of the course will include EO data processing and analysis including ML/AI, or embedded software, tiny ML and automation. The ideal candidate for this course will have some previous programming experience, as below.

- If you are primarily interested in data-analysis and ML/AI then some python experience is required.
- If you are primarily interested in embedded systems then some C/C++ and/or VHDL experience is required.

Who will deliver this course?
Led by the University of Portsmouth, this CPD course is a regional initiative of the Space South Central partnership of the Universities of Portsmouth, Southampton and Surrey, all of whom have a rich heritage in space. We also leverage the space cluster expertise of Space South Central Enterprise Network and the industry insight of Orange Tree Partnership. This **Securing the future of space: Space Software and Data/AI** course is fully funded by the UK Space Agency's Training Programmes Fund.

Expectations of commitment from delegates
Overall the delegates are expected to commit to a minimum of 48 hours of remote learning (16 in Phase 1, 32 in Phase 3) and to attend all of the 3 day in-person Phase 2 sessions, including networking and receptions/dinners.

Expectations of commitment from companies/organisations
Companies/organisations are expected to support their employees' participation in this course and release them to attend the 3 day in-person element, including networking and receptions/dinners.

We are interested in gauging the success of this course from the organisation's perspective as well as from the learner's point of view. We therefore expect a commitment from the organisations to engage with us for assessment, including baselining expectations, what success looks like, and measuring impact.

Engagement of the organisation to co-create the bespoke Phase 3 projects and identify desired skills outcomes will be critical to the success of this course and ensure employees are receiving the appropriate 'bespoke' training.

Course Content

Course Overview

This course will provide an introduction to the digital space sector, including the direction of standards/regulation and a strategic understanding of funding opportunities. It is divided into 3 Phases (see Fig. 1 below) to provide both breadth and depth of understanding.

Phase 1 will provide a breadth of understanding about software and data usage in the space sector. Phases 2 and 3 develop an in-depth understanding of space-software, and/or data processing and analysis and state-of-the-art AI/ML as applied to a space-sector sub-field.

Phase	Duration	Delivery	Schedule								
1	4-week	Online (16 hrs)	Introduction lecture course to software and data usage in the space sector								
	3-day		9-10.30	10.30-11.00	11-12.30	12.30-13.30	13.30-15.00	15.00-15.30	15.30-17.00	18.30-21.00
		Tuesday 1st Oct								Welcome dinner and reception
		Wednesday 2nd Oct	Software best practices	Coffee/Tea	EO data & processing / Embedded software 101	Lunch	EO data analysis / Embedded software 101	Coffee/Tea	AI 101	
		Thursday 3rd Oct	ML v's deep learning / Real time processing	Coffee/Tea	Segmentation and object tracking / Tiny AI and automation	Lunch	Generative AI / Cyber security	Coffee/Tea	Project kick-off	Course Dinner
		Friday 4th Oct	Trust in safety critical software and Software/AI standards	Coffee/Tea	Bid writing for the space sector	Lunch and tour				
2										
3	8-week	Online (32 hrs)	1 hour mentorship per week, participant to spend total of 4-hours per week on project incl. mentorship							

Fig. 1: Course overview and Phase 2 provisional lecture structure showing the two streams, detailed structure subject to change based on lecture timetables and bespoke skills discussions with employers.

Phase 1 Lectures

Phase 1 will be delivered through 16 hours of pre-recorded lectures and assessment. (learner time expectation: 4 hours per week, on average)

Phase 1	Online lectures	Taught by
Theme 1	An introduction to this course and software for the space sector An overview of the course and structure and an introduction to software for space. 2 hours	Dr. Becky Canning (Portsmouth), Dr. Chris Bridges (Surrey)
Theme 2	The space environment and debris An introduction to the space environment covering space weather and infrastructure damage, space debris and an overview of effects on solar panels and the robotics of their maintenance. 3 hours.	Prof. Keith Ryden (Surrey), Dr. Olugbenga Olumodimu (Portsmouth), Prof. Hugh Lewis (Southampton)
Theme 3	Cyber security challenges in the space sector Challenges and trustworthiness of space data from a hardware and software perspective. 2 hours.	Prof. Ioana Boureanu (Surrey), Dr. Basel Halak (Southampton)
Theme 4	Embedded software and space An introduction to embedded software including: Control systems, Digital Signal Processing; FPGA's. 3 hours.	Prof. Victor Becerra (Portsmouth), Dr. John Chiverton (Portsmouth), Dr. Mojtaba Ghodsi (Portsmouth)
Theme 5	Space Applications Applications of space software incl. 3D printing and spacecraft design, payload and instrumentation miniaturisation, and earth observation applications in disaster, risk and resilience. 3 hours.	Prof. Scott Walker (Southampton), Dr. Hanna Sykulska-Lawrence (Southampton), Prof. Richard Teeuw (Portsmouth)
Theme 6	An introduction to Machine Learning and a computational primer for Phase 2 An introduction to Machine Learning and computational setups for the course. 3 hours.	Dr. Becky Canning (Portsmouth), University of Portsmouth Research Software Engineer (RSE) Team

Fig. 2: Phase 1 online lecture series and provisional lecturers. Online lectures to be completed before phase 2 and assessed via an online questionnaire.

Phase 2 In-person Residential Days
Phase 2 is delivered as 3 days in-person hosted mainly on the city-centre campus of the University of Portsmouth. (learner time expectation: Three days in-person, plus travel to and from Portsmouth)

Phase 3 In-depth Projects
Phase 3 will span 8 weeks immediately following Phase 2 and will take a deeper dive into a code-based online project, co-created with industry. This project will demonstrate the learner's knowledge of software and algorithmic design and problem-solving skills, bespoke to the specific training needed in the sector (learner time expectation: 4 hours per week, on average, including 1 hour supervision).

Practicalities

Next Steps
The course materials will be delivered through the online Moodle-CPD platform. Phase 1 lectures will be delivered to the platform weekly after the 21st August and will be delivered by 'Theme' (see Fig. 2 above). Reference materials for Phase 2 and 3 will appear on the same platform.

Using Moodle
Moodle is the University of Portsmouth's virtual learning environment (VLE) hosting course learning materials and activities. Moodle is available 24-hours a day, 7-days a week. You can access your course and module learning materials from Moodle via smartphone, laptop or desktop computer. **You will receive an email on 21st August 2024 with your Moodle account details** and instructions for accessing the content.

On Moodle, you can access:
- module information
- course information
- links to online resources and reading lists
- learning activities
- recorded videos of teaching sessions
- news, announcements and discussion forums
- assessment information

Once you have received your Moodle account details, further support can be requested via emailing cadi-digital@port.ac.uk .

Accommodation
During this pilot year of UKSA funding, accommodation will be provided for the in-person days, as will most meals. The delegate will need to provide their own transport to and from the in-person days, plus one meal on the Wednesday evening. Note that the catering for Tuesday evening's drinks and reception will be light fare, so the delegate may also need to source their own meal that evening if a more substantial meal is required.

Details of the accommodation arrangements will be communicated prior to the Phase 2 start.

Travelling to Portsmouth
Portsmouth is easily accessible through national and international sea, air, rail, and road connections. Travelling around the city is also very easy and most sites of interest are within walking distance. We also have an efficient public bus service and ample taxi services.

London Heathrow Airport
If you fly into London Heathrow Airport, we recommend you to take a direct coach to Portsmouth. The journey takes about 3 hours and 45 minutes. See the National Express website for more details about coach times and prices. If you do choose to take a taxi, you should book it in advance to get the best offers possible.

London Gatwick Airport
If you arrive at London Gatwick Airport, we recommend you take the direct train to Portsmouth and Southsea Railway Station. The journey takes about 90 minutes. You can find the latest travel times and ticket prices on the National Rail website. Or you can take a coach from your terminal at Gatwick direct to Portsmouth Harbour Bus Station. The journey takes about 1 hour and 45 minutes. You'll find a full timetable and ticket price information on the National Express website.

Southampton Airport
If you fly into Southampton Airport, you should take the train from Southampton Airport Parkway to Portsmouth and Southsea Railway Station. You will need to change trains at either Eastleigh, Cosham, Havant or Southampton Central. The journey takes about 60 minutes. Please check the National Rail website for the latest travel times and ticket prices.

Parking
There are various University car parks, but permits are required. More information about University car parking can be found here:
http://www.port.ac.uk/departments/services/estates/campusenvironment/carparking/visitors
It may also be possible to make arrangements for parking with Portsmouth City Council.

Park and Ride
Portsmouth has an excellent Park and Ride service, bringing visitors quickly and easily to the centre of the city.

Public Transport
Portsmouth has a number of local train stations, including Portsmouth & Southsea, close to the University itself, and Portsmouth Harbour, for the shops and restaurants at Gunwharf Quays.

There are also bus services providing transportation locally and to other areas of the region, such as Southampton and Chichester, as well as ferries to Gosport, the Isle of Wight, France, Spain and the Channel Islands.

Disabled Access
The University venues selected for the Conference are largely suitable for those with physical disabilities related to mobility. For those with a sensory impairment, there are induction loops in most major lecture theatres.
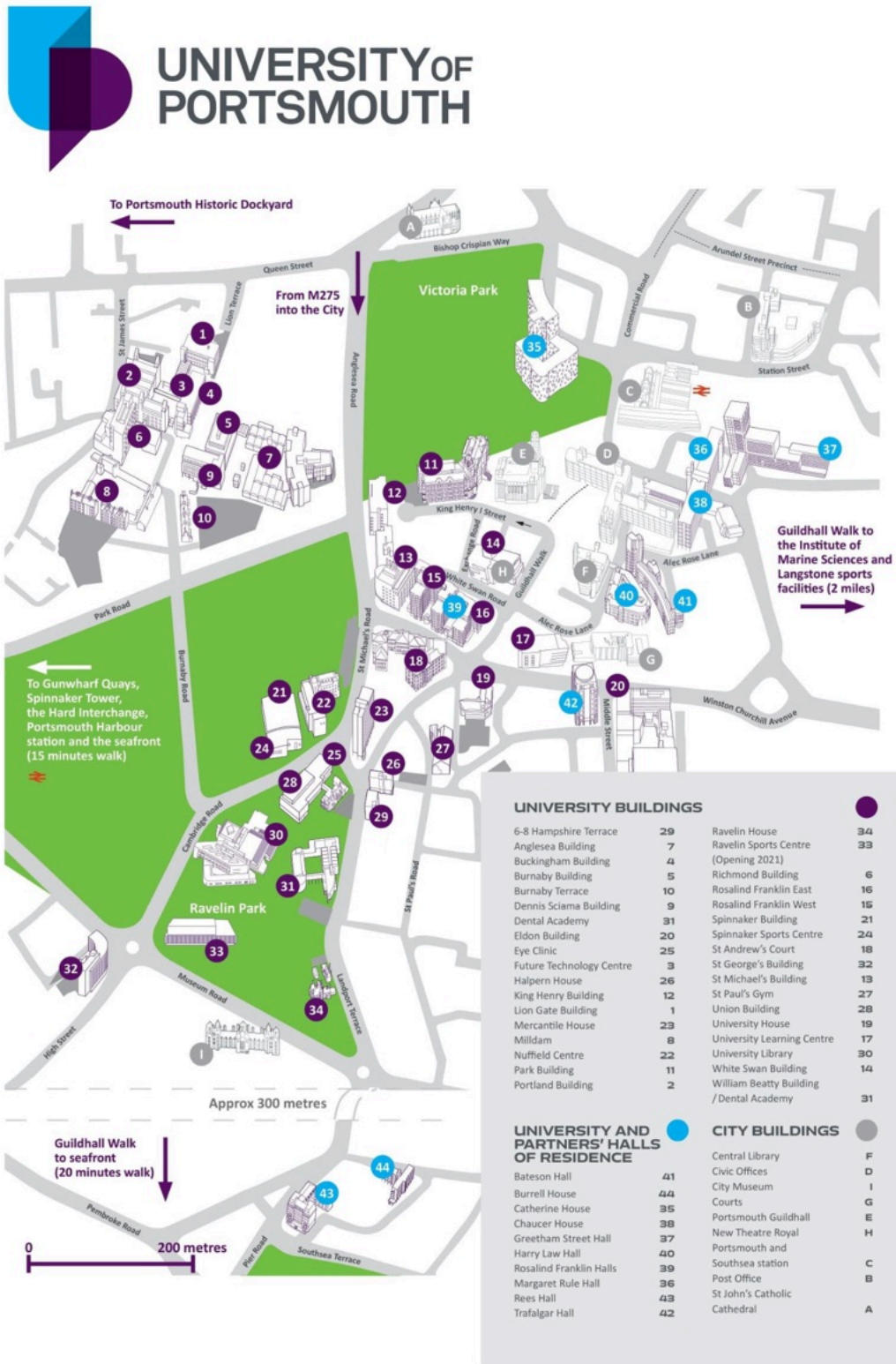
For full details on accessibility within the University of Portsmouth, including assessment and information on University buildings, please visit:
http://www.disabledgo.com/organisations/university-of-portsmouth/main-2

Contact us
If you have any questions or need further guidance, please contact Dan Smith, Space South Central, Business Development Manager daniel.smith@port.ac.uk .

Map

UNIVERSITY OF PORTSMOUTH

To Portsmouth Historic Dockyard

Queen Street

From M275 into the City

Victoria Park

Bishop Crispian Way

Arundel Street Precinct

Station Street

King Henry I Street

Guildhall Walk to the Institute of Marine Sciences and Langstone sports facilities (2 miles)

Alec Rose Lane

To Gunwharf Quays, Spinnaker Tower, the Hard Interchange, Portsmouth Harbour station and the seafront (15 minutes walk)

Park Road

Winston Churchill Avenue

Ravelin Park

Museum Road

Approx 300 metres

Guildhall Walk to seafront (20 minutes walk)

Pembroke Road

0   200 metres

Southsea Terrace

UNIVERSITY BUILDINGS ●

6-8 Hampshire Terrace	29	Ravelin House	34
Anglesea Building	7	Ravelin Sports Centre (Opening 2021)	33
Buckingham Building	4		
Burnaby Building	5	Richmond Building	6
Burnaby Terrace	10	Rosalind Franklin East	16
Dennis Sciama Building	9	Rosalind Franklin West	15
Dental Academy	31	Spinnaker Building	21
Eldon Building	20	Spinnaker Sports Centre	24
Eye Clinic	25	St Andrew's Court	18
Future Technology Centre	3	St George's Building	32
Halpern House	26	St Michael's Building	13
King Henry Building	12	St Paul's Gym	27
Lion Gate Building	1	Union Building	28
Mercantile House	23	University House	19
Milldam	8	University Learning Centre	17
Nuffield Centre	22	University Library	30
Park Building	11	White Swan Building	14
Portland Building	2	William Beatty Building / Dental Academy	31

UNIVERSITY AND PARTNERS' HALLS OF RESIDENCE ●

Bateson Hall	41
Burrell House	44
Catherine House	35
Chaucer House	38
Greetham Street Hall	37
Harry Law Hall	40
Rosalind Franklin Halls	39
Margaret Rule Hall	36
Rees Hall	43
Trafalgar Hall	42

CITY BUILDINGS ●

Central Library	F
Civic Offices	D
City Museum	I
Courts	G
Portsmouth Guildhall	E
New Theatre Royal	H
Portsmouth and Southsea station	C
Post Office	B
St John's Catholic Cathedral	A

UNIVERSITY OF PORTSMOUTH   UNIVERSITY OF SURREY   University of Southampton   SPACE SOUTH CENTRAL   UK SPACE AGENCY

Annex 1 - Meet the Lecturers

Dr. Becky Canning

Becky is Deputy Director (Space) and an Associate Professor at the Institute of Cosmology and Gravitation at the University of Portsmouth. Becky received her PhD in Astronomy from the University of Cambridge. She held a NASA Einstein Fellowship at Stanford University in the USA where she was selected as one of 25 'MIT Rising Stars in Physics' in 2018. Becky's key research interests are in the evolution of supermassive black holes and their host galaxies and in the application of computational models and data science techniques including efficient AI algorithms for low-power systems such as satellites.

Dr. Chris Bridges

Chris is a Reader in Onboard Data Handling in the School of Mathematics, Physics and Space at University of Surrey. Chris' research interests include software-defined systems, real-time embedded systems, machine learning computing implementations, and astrodynamics computing methods. He designs, builds, and operates satellites and payloads with industry and agency partners.

Professor Keith Ryden

Keith is currently the Director of the Surrey Space Centre in the School of Mathematics, Physics and Space at University of Surrey. Keith's own field of research concerns the effects of space weather and radiation on satellites, aircraft and ground systems and how to protect them. He has participated in national and international projects with the European Space Agency and NASA.

Dr. Olugbenga Olumodimu

Olugbenga leads the Space weather and hardware development pillar for University of Portsmouth. Over the last two decades, Olugbenga has made key contributions to the global space weather community through the development of models that are currently being deployed to predict high frequency radio wave absorption and other space weather phenomena. He had

his PhD in Physics specialising in Space Plasma Environment and Radio Sciences (SPEARS) from Lancaster University. He has worked alongside key institutions such as NASA, ESA, United Nations Office of Outer Space Affairs (UNOOSA) and the African Union office for science and Innovation and is a Fellow of the Royal Astronomical Society (RAS) and member of The Institute of Physics (IoP) and The Association of Project Managers.

Professor Hugh Lewis
Hugh is Professor of Astronautics at the University of Southampton. His research interests range from Earth Observation and Artificial Intelligence to Space Debris, Space Safety and Space Sustainability. He has been a member of the UK Space Agency delegation to the Inter-Agency Space Debris Coordination Committee (IADC) for more than 20 years and is author of a variety of computational models used to support UK leadership in space debris and space sustainability.

Professor Ioana Boureanu (Carlson)
Ioana is a Professor in Secure Systems in the School of Computer Science and Electronic Engineering at University of Surrey. Ioana is the Director of Surrey Centre for Cyber Security. Her research focuses on (automatic) analysis of security using mainly logic-based formalisms, as well as on provable security and applied cryptography.

Dr. Basel Halak
Basel is an Associate Professor of secure electronics and the Director of the Cyber Security Academy with the University of Southampton. He is a Visiting Scholar with the Technical University of Kaiserslautern, an Industrial Fellow of the Royal Academy of Engineering, a Senior Fellow of the Higher Education Academy, and a National Teaching Fellow of Advance HE U.K. His research interests include hardware security, digital design, and embedded systems. Basel has served on many technical program committees, including HOST, IEEE DATE, DAC, IVSW, ICCCA, ICCCS, MTV, and EWME. He is a

member of the Hardware Security Working Group of the World Wide Web Consortium (W3C). He is an Associate Editor of IEEE Access and the Editor of the IET Circuits, Devices and Systems Journal

Professor Victor Becerra
Victor is currently a Professor of Power Systems Engineering at the School of Energy and Electronic Engineering, University of Portsmouth. He received his PhD in Control Engineering from City University of London. He has worked in power systems analysis and control systems design at C.V.G. Edelca, Caracas, Venezuela. He was a Postdoctoral Research Fellow in the Control Engineering Research Centre at City University of London and an academic at the School of Systems Engineering, University of Reading, where he became a Professor of Automatic Control. His current research interests include various issues related to power systems, automatic control, plant condition monitoring, solar energy systems and energy storage. He is a Fellow of the IET, a Chartered Engineer, and a Senior Member of the IEEE. During his career, he has received external research funding from the EPSRC, the Royal Academy of Engineering, the European Space Agency, the Technology Strategy Board, Innovate UK, the EU, and various UK companies.

Dr. John Chiverton
John is a Senior Lecturer at the University of Portsmouth. John has worked in signal and image processing for over twenty years with some established collaborators and a track record of supporting research projects in the UK at Surrey, Bristol and Portsmouth Universities as well as in Thailand. This has included funding from Google and Mitsui Sumitomo Insurance Welfare Foundation. He began academic research with a doctoral training grant in the Centre for Vision, Speech and Signal Processing (CVSSP) at the University of Surrey in the early 2000s, investigating medical image analysis applied to MRI, PET and CT. He is a member of the IET and IEEE. He received awards from IEEE and IPEM and leads work on techniques for the automated analysis of 3D imaging data. The work spans multiple disciplines while concentrating on feature extraction and quantitative inference.

Dr. Mojtaba Ghodsi
Mojtaba is a Senior Lecturer of Instrumentation and Measurement

Systems at the School of Electrical and Mechanical Engineering at the University of Portsmouth. He received his PhD in Precision Engineering from the University of Tokyo (2007) and continued his research as a JSPS postdoctoral fellow (2009) at the University of Tokyo, Japan. His main research interests are around smart materials and structures to develop actuators, sensors, energy harvesters, vibration control, NDT, and mechatronics systems.

Professor Scott Walker
Scott is a Professor of Aerospace Structures at the University of Southampton. His research interests include the application of 3D printing to Spacecraft Structures, Multifunctional Structures and Satellite Deployable Structures. He has performed both experimental testing and theoretical modelling in each of these research areas. Scott is also the convenor of Southampton short courses on Space Systems Engineering, which have delivered continuing professional development opportunities to the space industry for many years.

Dr. Hanna Sykulska-Lawrence
Hanna is an Associate Professor at the University of Southampton. Hanna's research interests involve the miniaturization of scientific instrumentation for the in-situ study of planets. With a focus on instrument and new technology development, she has led the development of a miniature wideband radiometer to study planetary atmospheres and the miniaturization of a Raman Spectrometer for Jupiter's moon Europa. Previously, she has worked on the miniaturization of a wind sensor for Mars, a MEMS microseismometer and bolometer detector for a lunar mission, and the design, fabrication, and operation of two microscopes on NASA's Phoenix Mars Lander.

Professor Richard Teeuw
Richard is Professor of Geoinformatics & Disaster Risk Reduction at the University of Portsmouth. He is an expert in applied remote sensing and GIS, e.g. for extreme weather event mapping for emergency managers (Ordnance Survey) and for

agriculture insurance (SPRINT funding); monitoring oil pollution in Nigeria (Shell) and illegal gold mining in Colombia (UK Space Agency & ESRC). He led a team surveying hurricane impacts in Dominica, providing 'Build Back Better' guidelines (NERC). In the UKSA-funded CommonSensing project, his team applied satellite data to climate resilience in island states; with the World Food Programme they are developing strategies for post-cyclone search and rescue, using machine learning with drone and satellite imagery.

Victoria Christmas

Victoria founded Orange Tree to provide specialist expertise to companies on developing their bidding strategy and key proposals. She works across multiple sectors supporting industry and academia developing sound actionable strategies, managing bids and developing processes. She has worked with around 200 space companies in the last five years enabling them to unlock opportunities in the space sector. She has worked with ESA and UKSA driving UK companies to secure funding and commercialise new developments. Her bidding career spans twenty years across defence, commercial and academic sectors. Victoria is an award-winning bid professional, a trained mentor and a STEM Ambassador with a passion for developing capability in others.

Additional Contributors

In addition to the lecturers above the course will also be supported by the University of Portsmouth Research Software Engineer team, part of the Institute of Cosmology and Gravitation's Software Innovation Service and the Risk, Reduction and Resilience Research group hosted in the new Center of Excellence in Defence, Risk and Resilience.